CLAIMS

What is claimed is:

1. A light valve for use in high contrast reflective microdisplays, comprising:

a twisted nematic mode reflective liquid crystal cell;

a color filter positioned to accept non-polarized light incident to the light valve;

a linear polarizer positioned between said color filter and said liquid crystal cell;

an analyzer positioned in the path of the light reflected by said liquid crystal cell; and

a retarder positioned between said liquid crystal cell and said analyzer in the path of the light reflected by said liquid crystal cell;

wherein light incident to the light valve is generally off-axis to said liquid crystal cell;

whereby said retarder(s) function to decrease ellipticity and alter the polarization axis of light reflected by said liquid crystal cell.

2. The light valve of claim 1 wherein said liquid crystal cell is an LCoS cell.

3. The light valve of claim 1 wherein light incident to the light valve is between 10° and 20° off-axis.

4. The light valve of claim 3 wherein light incident to the light valve is 15° off-axis.

5. The light valve of claim 1 wherein said liquid crystal cell has a twist angle ranging from 40° to 65°.

6. The light valve of claim 5 wherein said liquid crystal cell is in 45° twisted nematic mode.

7. The light valve of claim 1 wherein the horizontal axis of said polarizer and the horizontal axis of said analyzer are 90° apart.

8. A light valve for use in high contrast reflective microdisplays, comprising:

a twisted nematic mode reflective liquid crystal cell;

a color filter positioned to accept non-polarized light incident to the light valve;

a linear polarizer positioned between said color filter and said liquid crystal cell;

an analyzer positioned in the path of the light reflected by said liquid crystal cell; and

a first retarder positioned between said liquid crystal cell and said analyzer in the path of the light reflected by said liquid crystal cell;

a second retarder positioned between said first retarder and said analyzer in the path of the light reflected by said liquid crystal cell;

wherein light incident to the light valve is generally off-axis to said liquid crystal cell; and

whereby said first retarder and said second retarder function to decrease ellipticity and alter the polarization axis of light reflected by said liquid crystal cell.

9. The light valve of claim 8 wherein said liquid crystal cell is an LCoS cell.

10. The light valve of claim 8 wherein light incident to the light valve is between 10° and 20° off-axis.

11. The light valve of claim 10 wherein light incident to the light valve is 15° off-axis.

12. The light valve of claim 8 wherein said liquid crystal cell has a twist angle ranging from 40° to 65°.

13. The light valve of claim 12 wherein said liquid crystal cell is in 45° twisted nematic mode.

14. The light valve of claim 8 wherein the horizontal axis of said polarizer and the horizontal axis of said analyzer are 90° apart.

15. The light valve of claim 8 wherein said first retarder is positioned having a retarder angle at 0° from a horizontal axis and said second retarder is positioned having a retarder angle at 45° from a horizontal axis.

16. The light valve of claim 8 wherein said first retarder has a retardation value ranging from 20 nanometers to 230 nanometers and said second retarder has a retardation value ranging from -9.5 nanometers to 1 nanometer in a red band of light.

17. The light valve of claim 16 wherein said first retarder has a retardation value centered at 110 nanometers and said second retarder has a retardation value centered at -5 nanometers in a red band of light.

18. The light valve of claim 8 wherein said first retarder has a retardation value ranging from 20 nanometers to 200 nanometers and said second retarder has a retardation value ranging from -8 nanometers to 0 nanometers in a green band of light.

19. The light valve of claim 18 wherein said first retarder has a retardation value centered at 95 nanometers and said second retarder has a retardation value centered at -5 nanometers in a green band of light.

20. The light valve of claim 8 wherein said first retarder has a retardation value ranging from 20 nanometers to 170 nanometers and said second retarder has a retardation value ranging from -7 nanometers to 0 nanometers in a blue band of light.

21. The light valve of claim 20 wherein said first retarder has a retardation value centered at 85 nanometers and said second retarder has a retardation value centered at -4 nanometers in a blue band of light.

22. A light valve for use in high contrast reflective microdisplays, comprising:

a twisted nematic mode reflective liquid crystal cell;

a color filter positioned to accept non-polarized light incident to the light valve;

a linear polarizer positioned between said color filter and said liquid crystal cell;

an analyzer positioned in the path of the light reflected by said liquid crystal cell; and

a retarder positioned between said liquid crystal cell and said analyzer in the path of the light reflected by said liquid crystal cell;

wherein light incident to the light valve is generally off-axis to said liquid crystal cell;

whereby said retarder functions to decrease ellipticity and alter the polarization axis of light reflected by said liquid crystal cell.

23. The light valve of claim 22 wherein said liquid crystal cell is an LCoS cell.

24. The light valve of claim 22 wherein light incident to the light valve is between 10° and 20° off-axis.

25. The light valve of claim 23 wherein light incident to the light valve is 15° off-axis.

26. The light valve of claim 22 wherein said liquid crystal cell has a twist angle ranging from 40° to 65°.

27. The light valve of claim 26 wherein said liquid crystal cell is in 45° twisted nematic mode.

28. The light valve of claim 22 wherein the horizontal axis of said polarizer and the horizontal axis of said analyzer are 90° apart.

29. The light valve of claim 22 wherein said retarder has a retardation value ranging from 430 nanometers to 630 nanometers and a retardation angle ranging from 87.6° to 90.2° in a red band of light.

30. The light valve of claim 29 wherein said retarder has a retardation value centered at 530 nanometers and a retardation angle centered at 89° in a red band of light.

31. The light valve of claim 22 wherein said retarder has a retardation value ranging from 350 nanometers to 550 nanometers and a retardation angle ranging from 87.5° to 90.5° in a green band of light.

32. The light valve of claim 31 wherein said retarder has a retardation value centered at 460 nanometers and a retardation angle centered at 89° in a green band of light.

33. The light valve of claim 22 wherein said retarder has a retardation value ranging from 280 nanometers to 460 nanometers and a retardation angle ranging from 87.7° to 90.3° in a blue band of light.

34. The light valve of claim 33 wherein said first retarder has a retardation value centered at 370 nanometers and a retardation angle centered at 89° in a blue band of light.

35. A method for improving the contrast of an off-axis light valve having a color filter, a linear polarizer, a twisted nematic mode reflective liquid crystal cell, and an analyzer, comprising the steps of:

determining the state of polarization of light after being reflected by said liquid crystal cell and before passing through said analyzer;

plotting a first point on a sphere representing a first polarization state of light reflected by said liquid crystal cell;

choosing a retarder angle for a first retarder;

plotting a first retarder point on said sphere representing said retarder angle of said first retarder;

plotting a first circle on a surface of said sphere centered at said first retarder point and having along the circle radius said first point;

determining a second point along the first circle radius at the intersection of said first circle with a plane passing through a line representing the linear polarization state of the analyzer;

calculating the retarder value of said first retarder as a function of the number of radians from said first point to said second point and the wavelength of light reflected by the liquid crystal cell;

choosing a retarder angle for a second retarder;

plotting a second retarder point on a sphere representing said retarder angle of said second retarder;

plotting a second circle around said plane centered at said second retarder point;

determining a third point along said second circle radius at the intersection of said second circle with said line representing the linear polarization state of the analyzer;

calculating the retarder value of the second retarder as a function of the number of radians from said second point to said third point and the wavelength of light reflected by the liquid crystal cell; and

placing said first and second retarders having chosen retarder angles and calculated retarder values between said analyzer and said liquid crystal cell in the path of light reflected by the liquid crystal cell.